IS 9115 (2002): Method for Estimation of Incompressible Fluid Flow in Closed Conduits by Bend Meters [WRD 1: Hydrometry]

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भारतीय मानक

बेन्ड मीटरों द्वारा बन्द नालियों के असंपीड्य द्रव के अनुमान की पद्धति

(पहला पुनरीक्षण)

Indian Standard

METHOD FOR ESTIMATION OF INCOMPRESSIBLE FLUID FLOW IN CLOSED CONDUITS BY BEND METERS

(First Revision)

ICS. 17.120.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 2002

Price Group 2

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Fluid Flow Measurement Sectional Committee had been approved by the Water Resources Division Council.

Advantages of bend meters are: (a) there is no additional resistance to flow as an existing bend may be suitably used as bend meter; and (b) as it is part of the pipe line, no additional cost except for the manometry is involved.

This standard was first published in 1979. In this first revision, modifications have been introduced in the determination of the value of discharge coefficient based on a formula with Reynolds Number as a parameter apart from general updating the various clauses of the standard.

There is no corresponding ISO standard on this subject.

This standard is one of the series of standards on methods of measurement in closed conduits. Other standards published so far in the series are:

IS 2951(Part 1) : 1965	Recommendation for estimation of flow of liquids in closed conduits: Part 1 Head loss in straight pipes due to frictional resistance
IS 2951 (Part 2) : 1965	Recommendation for estimation of flow of liquids in closed conduits: Part 2 Head loss in valves and fittings
IS 2952 (Part 2) : 1975	Recommendation for methods of measurement of fluid flow by means of orifice plates and nozzles: Part 2 Compressible fluids
IS 4477 (Part 2) : 1975	Methods of measurement of fluid flow by means of venturi meters: Part 2 Compressible fluids
IS 9118 : 1979	Method for measurement of pressure by means of manometer
IS 9119 : 1979	Method for flow estimation by jet characteristics (approximate method)
IS 14615 (Part 1) : 1999/ ISO 5167-1 : 1991	Measurement of fluid flow by means of pressure differential devices : Part 1 Orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

METHOD FOR ESTIMATION OF INCOMPRESSIBLE FLUID FLOW IN CLOSED CONDUITS BY BEND METERS

(First Revision)

1 SCOPE

This standard provides the specification and installation of bend meters used as primary elements in the measurement of clear, single phase, incompressible fluid flow. Accuracy of this measuring device depends upon the sharpness of bend and the velocity of flow, elimination of entrapped air in the upstream which is an essential condition, and on periodic calibration as no reliable data exists on the influence of roughness of pipe on the coefficient of discharge of the meter. This device is not recommended for use in very sharp bends with *R/d* (radius of curvature to diameter of pipe) ratio less than 1.25 and velocity less than 1 m/s.

2 REFERENCE

The Indian Standard listed below contains provision which through reference in this text, constitutes provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
9118 : 1979	Method for measurement of pressure by means of manometers

3 TERMINOLOGY

3.1 Bend Meter — Bend meter is a device where a differential pressure caused by the centrifugal action as the flow passes through the bend is made use to estimate the rate of flow.

4 PRINCIPLE OF THE METHOD OF MEASUREMENT

Fluid flowing through a bend experiences a centrifugal force because of the curvature in flow. There is pressure difference between the inside and outside of this deflected flow. This differential pressure may be used to measure the rate of flow in the pipe line. Any ordinary commercial bend fitted in a system may be used by fitting two pressure tapings, one at the inside and the other at the outside as shown in Fig. 1.

5 INSTALLATION

5.1 The bend of the same diameter as the pipe should be located such that there is at least 30 diameters of straight pipe on the upstream and 10 diameter of straight pipe on the downstream side.

5.2 It shall be ensured that the flow runs full in the bend.

5.3 Pressure Taps for 90° Bends

5.3.1 *Location*

The pressure taps are usually located at the middle of the elbow, that is along a 45° radius from each flange diametrically opposite to one another, at the extreme inside and extreme outside of the bend. With pressure taps along the radius inclined at 45° to the inlet, the flow may be in either direction, provided the straight lengths specified in **5.1** are available.

5.3.1.1 Pressure taps along 45° radius are preferred as the pressure differential measured will be large for a given rate of flow compared to the differential pressure from the pressure taps located along any other radius. But with increasing Reynolds number, for a given diameter of pipe the chances of early separation, and consequently pressure instability are greater with tapings along radius inclined at 45° or more from the inlet end. In such cases tapings may be at 22½° measured from the inlet end. Under such conditions, values of coefficients for discharge as defined in **7.1** should be obtained experimentally.

5.3.2 *Size of Pressure Taps*

The bore of the pressure tapings shall be circular. The diameter of the tapings in general lie between 6 mm and 12 mm but in any case is not to be greater than 0.1 *d* where *d* is the internal diameter of the elbow. The bore of the tapings will be along a radius perpendicular to the axis of bend and also shall be in a plane containing the axis of bend. The inside edges of the pressure tapings should be free from burrs. It is recommended that the length of the bore hole should be equal to or greater than twice the diameter of the hole.

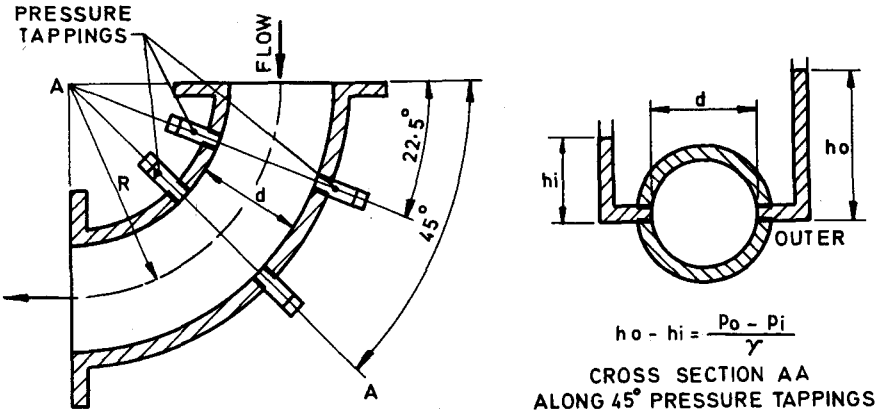

FIG. 1 TYPICAL SKETCH OF A BEND METER

5.3.3 *Measurement of Pressure*

Differential pressure $P_o - P_i$ shall be measured suitably using a differential pressure gauge or a differential manometer (*see* IS 9118).

5.4 Pressure Taps for Bends Less Than 90°

Commercial elbows having angle of bend less than 90° may be advantageously used. In the case of 30°, 45°, 60° elbows the chance of separation is much less and pressure tapings may be adopted along the middle radius. It is necessary to calibrate the elbow before use. If the pressure tapings are along the middle radius, the bend meter may be used for flow in both directions subject to fulfilling the conditions laid down in **5.1**.

6 SPECIFICATION FOR BEND

6.1 The bend should be of flanged type with conduit diameter, d, same as that of the approach pipe.

6.2 Wherever greater accuracy is required bend meter should be calibrated periodically under identical conditions.

6.3 Materials

The bend meter should be made of cast iron, mild steel or rigid PVC or any other material which can withstand the flow of the liquid without any chemical reaction, corrosion or abrasion. PVC pipes may be preferred since they retain their smoothness for long periods.

7 ESTIMATION OF FLOW RATE

7.1 The flow rate may be obtained by using the following basic equation:

$$Q = \frac{Cd.\ \pi.\ d^2}{4}\sqrt{\frac{(P_o - P_i)\,2g}{\gamma}}$$

where

Q = rate of flow,

$Cd.$ = discharge coefficient,

d = diameter of bend,

$(P_o - P_i)$ = pressure differential between the outer and inner pressure tapings, both tapings being at the same horizontal plane,

g = gravitational acceleration, and

γ = specific weight of the flowing fluid measured.

7.2 Discharge Coefficient

The value of discharge coefficient depends on the bend-radius to diameter ratio that is R/d, surface roughness and the Reynolds number of flow. Since all the above three factors vary widely, calibration of bend is essential, if reliable coefficients are required. The following formula may be used for a 90° circular bend for preliminary calculation of discharge with an error of ± 5 percent:

$$Cd. = \sqrt{\frac{R}{2d}} - 6.5\sqrt{\frac{R}{2d}} \times \sqrt{\frac{1}{R_e}}$$

where

R = Radius of the bend,

d = inside diameter of the bend, and

R_e = Reynolds number.

7.3 Periodical Calibration

It is essential to calibrate the bend meter periodically to limit the error within the specified limit of ± 5 percent since the flow characteristics will change with the ageing of the pipe.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Fluid Flow Measurement Sectional Committee, WRD 1

Organization	*Representative(s)*
Central Water Commission, New Delhi	SHRI S. K. DAS (***Chairman***)
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Bhakra Beas Management Board, Punjab	DIRECTOR (WR) SENIOR DESIGN ENGINEER (WR) (*Alternate*)
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National Physical Laboratory, New Delhi	RESEARCH OFFICER DIRECTOR (*Alternate*)
In Personal Capacity *[425/14 T. V. Nagar, Pune 411 037 (Maharashtra)]*	DR S. V. CHITALE
BIS Directorate General	SHRI S. S. SETHI, Director & Head (WRD) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI S. S. SETHI
Director (WRD), BIS

Bureau of Indian Standards

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